finite terms several most important partial differential equations of the second order, including the equation of continuity in a homogeneous incompressible fluid; and the chapters in which these equations are discussed are by far the most important and interesting in the work. Mr. Earnshaw is already known for his able treatment of the equation for the motion of a sound wave in the Philosophical Transactions for 1860, and no one can doubt the importance of the subjects suggested for consideration by this and other equations. The question is discussed whether there must necessarily exist an integral of every partial differential equation that can be proposed, and on this part of the subject we wish the author had extended his remarks. The real question considered seems however rather to be the possibility of the existence of a continuous function expressible in finite terms as an integral. With regard to the considerations having reference to certain physical problems, we should not expect to learn very much from the discussion of such questions, as the differential equation might admit of a solution incapable of satisfying the physical conditions.

We must notice one singular error made by Mr. Earnshaw. He concludes that the well-known partial differential equation of the second order of surfaces having their principal radii of curvature equal and of opposite signs at all points, admits of no integral, because the form of a surface possessing this property would be such as could not exist; but it is well known that the surface formed by the revolution of a catenary round its directrix does possess the property in question, and it is easy to see that this arises simply from the fact that the normal and radius of curvature in the catenary are equal and of opposite signs; the form of the surface is quite easy to conceive. A particular integral of the equation obtained by Poisson's method is also given in Boole's Differential Equations, chapter XV. Even admitting Mr. Earnshaw's reasoning, it would only establish the non-existence of a real surface possessing the required property. The integrals of the equation of continuity in three dimensions, and of one or two other equally important equations, we do not remember to have seen before, and they are perhaps the most general finite solutions the equations admit of. Of the value and power of the method it is impossible to speak at present; but we heartily commend Mr. Earnshaw's book to the reader as one containing much matter of great interest systematically and clearly developed and treated by a novel method. It is remarkable that the subject of partial differential equations has not attracted more attention than it has in recent years, as an advance in this quarter is more immediately felt in physics than an advance in any other pure mathematical subject. The present work will help to bring the matter prominently forward; and as the analysis is nowhere of a very difficult nature, it will probably come under the notice of many readers not accustomed to study mathematical memoirs on their appearance.

If the work had been intended to be a Treatise on the subject, we should have had good reason to object to the total omission of all reference to the usual methods, but the title and preface explain that this was not contemplated; it is one of the few English books containing original mathematics.

J. W. L. G.

OUR BOOK SHELF

Three and Four Place Tables of Logarithmic and Trigonometric Functions. By James Mills Peirce. 16 pp. (Boston: Ginn Brothers, 1871.)

PERHAPS the best way of treating this work, which does not contain a single word of explanation, will be to give a summary of the tables contained in it. First we have proportional parts of all numbers up to 100; then on one page three-place logarithms of numbers and of the six trigonometric functions, natural and logarithmic. On pages 4 and 5 we find four-place logarithms of numbers, then logarithms of sums and differences (Gaussian logarithms) also to four places, then follow tables of logarithmic trigonometric functions, inverse trigonometric functions (a new table, to which attention is specially invited, for finding angles from the logarithms of their trigonometric functions), traverse table, the correction of the middle latitude (in an improved form), and meridional parts.

In a prospectus issued by the publishers, it is stated as a result of experiment that it has been found that the times occupied, in regular computation, in doing one piece of work by tables of 4, 5, 6, and 7 places, are proportional to the numbers 1, 2, 3, and 4; hence it is that the author has drawn up the majority of the tables under review to 4 places as sufficient for ensuring the degree of accuracy usually required in computations of common surveying, engineering, &c.

The type employed is very clear, the arrangement of the work is good, and the printer's part has been well done; the book requires only a few words of elucidatory matter. There is on the last page a useful Table of Constants with their logarithms, here we observe a few symbols which are new to us, and which are presented to our notice on the Title-page.

After all the value of such a work consists in its accuracy, and that can only be tested by practice, "the greatest pains have been taken both in preparing and printing to secure perfect accuracy." We commend the work to the notice of such as agree with old Burton (Anatomy of Melancholy, pt. II., sec. 2), "What so pleasing can there be . . . if a man be more mathematically given (as) to calculate or peruse Napier's logarithms, or those tables of artificial sines and tangents, not long since set out by . . . . Edmund Gunter, which will perform that by addition and subtraction only, which heretofore Regiomontanus' tables did by multiplication and division." But then the same quaint writer advises those who are melancholy to square a circle; does it follow that all circle-squarers are melancholy? R. T.

The Laws of the Winds prevailing in Western Europe. By W. Clement Ley. Part I. (Stanford, 1872.)

EVEN when we differ from an author's conclusions, the work of one who shows himself an honest and capable inquirer has a just claim to our attention. Mr. Ley evidently writes from practical knowledge of his subject, and his assiduity in collecting and charting observations must have entailed on him an amount of labour which only those who have been engaged in similar work can thoroughly understand. Unfortunately, as it appears to us, he has confined his investigations almost entirely to the limits set forth on his title-page; and the winds of Western Europe, though highly suggestive and subject to more exact observation than any others except those of the United States, are by no means to be taken as representative. Mr. Ley has taken them as such, and has thus laid down a series of general propositions, which may be briefly summed up in one—that revolving storms are caused by the barometric depression consequent on heavy rain over a large area. He brings forward some curious home instances in illustration of this; but looking farther afield, on the slopes of the Himalayas—to mention only one locality—a much heavier and longer continued pre-

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cipitation than any he has instanced takes place every summer, and does probably cause a very great depression of the barometer, but certainly does *not* give rise to any winds such as he has described. On the hills of Khasia, again, where the unparalleled rainfall is as much as from 30 to 40 inches a day for days together, and puts the paltry $\frac{1}{2}$ or $\frac{3}{4}$ of an inch a day of Mr. Ley's examples almost beyond the pale of comparison, no such storms are generated. In the same way, the explanation of the eastward direction which these barometric depressions take in our latitudes, which differs only in its greater detail from that given by Prof. Mohn in the "Storm Atlas," is applicable only to temperate latitudes; the westward advance of tropical cyclones cannot be referred to it; and it seems to us improbable in the extreme that the course of a storm is regulated by one law in one part of the world, and by a totally distinct law in another. Besides this, in the detailed application of the law which he deduces for Western Europe, the author appears to fall into the mistake of attributing the rainfall of mountain districts to the mere contact of the moist air with the cold mountain slope; that this is not the case—that it is due rather to the hoist into the upper regions which the air receives on impinging against the slope—is curiously shown by the fact that, when the hills are not high, most rain falls on the lee side. One familiar instance of this will illustrate our meaning. The gauge which in all England shows the greatest rainfall is at Stockley Bridge, just above Seathwaite; it is distinctly under the lee of the ridge which joins Great Gable to Great End, and separates Wastdale from Borrowdale. The mist, blown in from seaward, fills Wastdale, and is lifted up the slope of this ridge (Stye Head Pass). Crossing over out of Wastdale, the mist curling up the hill is frequently so thick that the path cannot be seen 10 feet in advance; but immediately on reaching Stye Head Tarn the mist vanishes, to fall as rain over Seathwaite. But altogether, though we admit neither the author's premises nor his conclusions, his work is none the less highly interesting. It does not contain much that is new, but it discusses and illustrates the theories of Mohn and Buchan in greater detail than has yet been attempted. We would, however, decidedly object to the *ex cathedrâ* tone which is occasionally adopted. In empirical science very little is "obvious," and perhaps nothing is a "truism;" certainly the influence attributed to the earth's rotation is neither one nor the other, for it is denied, disputed, and doubted by very many capable meteorologists. J. K. L.

The Young Collector's Handy-book of Botany. By the Rev. H. P. Dunster. (London: L. Reeve and Co., 1871.)

We opened this little book with pleasure, hoping to find in it an addition to the too few popular manuals of botany, and the pleasure was increased by recognising at the end some familiar and excellent illustrations. Great therefore was our disappointment when we found that instead of "assisting the student in the beginning of his work by setting him forward on a right road," as is stated in the Preface to be its object, it would be far more likely to mislead him. Botany seems to be peculiarly unfortunate, in that every one who is fond of flowers thinks himself capable of writing a handbook, without himself possessing any accurate scientific knowledge of his subject. Some of the definitions given in this book are so bad that we should have been surprised to find them in the answers to the examination papers of the botanical classes in any of the great schools where natural science is now taught. Take four examples:—"Albumen: a gummy substance surrounding certain seeds;" "Embryo: the leaf in an immature state;" "Matrix: that upon which any other thing grows;" "Petals: leaves while in the corolla." After this we are somewhat prepared to hear that the corolla "is made up of petals which, when expanded, are the flower-leaves, *and* of the stamen and pistils;" and that "county collections (of ferns) are valuable as illustrations of the *fauna* of particular parts." We are utterly unable to see the object gained by the publication of this book, when beginners already have such admirable manuals as Oliver's "Lessons in Elementary Botany," Lindley's "School Botany," and Cooke's "Manual of Structural Botany," neither of which, by the way, is mentioned by Mr. Dunster in the list of books recommended to the learner. Especially are we unable to understand how the names of respectable publishers, who have issued many admirable works on natural history, come to be appended to a book of this character. As we see that it is intended to be the first of a series of Handy-books upon "the popular and recreative sciences," we would recommend the publishers to submit the manuscript of the remainder of the series to a competent judge before publication. A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressea by his correspondents. No notice is taken of anonymous communications.*]

Ocean Currents

Leaving out of account a few small inland seas, the globe may be said to have but one sea, as well as but one atmosphere. We have, however, accustomed ourselves to speak of parts, or geographical divisions, of the one great ocean, such as the Atlantic and the Pacific, as if they were so many separate oceans. We have become accustomed, also, to regard the currents of the ocean as separate, and independent of one another; and this idea has, no doubt, to a considerable extent, militated against the acceptance of the theory, that the currents are caused by the winds, and not by difference of specific gravity, for it leads to the conclusion that currents in a sea must flow in the direction of the prevailing winds blowing over that sea.

The true way of viewing the matter, as I hope to be able to show in my next letter on the cause of Ocean Currents, is to regard the various currents merely as members of one grand system of circulation, produced, not by the trade winds alone, as some suppose, but by the combined action of all the prevailing winds of the globe, regarded also as one system of circulation.

If the winds be the impelling cause of currents, the *direction* of the currents will depend upon two circumstances, viz. (1) the direction of the prevailing winds of the globe; and (2) the conformation of sea and land. It follows, therefore, that as a current in any given sea is but a member of a general system of circulation, its direction is determined, not alone by the prevailing winds blowing over the sea in question, but by the general system of prevailing winds. It may, consequently, sometimes happen that the general system of winds may produce a current directly opposite to the prevailing wind blowing over the current.

Taking into account the effects resulting from the conformation of sea and land, the system of ocean currents is found to agree exactly with the system of the winds. I trust to be able to show that all the principal currents of the globe, the Gibraltar current not excepted, are moving in the exact direction in which they ought to move—assuming the winds to be the sole impelling cause. Given the system of winds and the conformation of sea and land, the direction of all the currents of the ocean, or more properly the system of oceanic circulation, can be determined *a priori*. Or given the system of the ocean currents, together with the conformation of sea and land, and the direction of the prevailing winds can also be determined *a priori*. Or, thirdly, given the system of winds and the system of currents, and the conformation of sea and land may be, at least, roughly determined. For example, it can be shown by this means that the Antarctic regions are probably occupied by a continent, and not by a number of separate islands, nor by a sea.

The influence of the rotation of the earth on ocean currents has certainly been greatly over-estimated. Rotation, as is well known, exercises no influence in generating motion in any body placed on the earth's surface; but if this body be already in motion, no matter in what direction the motion may be, rotation will deflect it to the right on the northern hemisphere, and to the left on the southern hemisphere, as has been shown by Mr. Ferrel. But it must be borne in mind that the deflecting power of rotation depends wholly on the rate a

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